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(54) **LIQUID COOLING APPARATUS**

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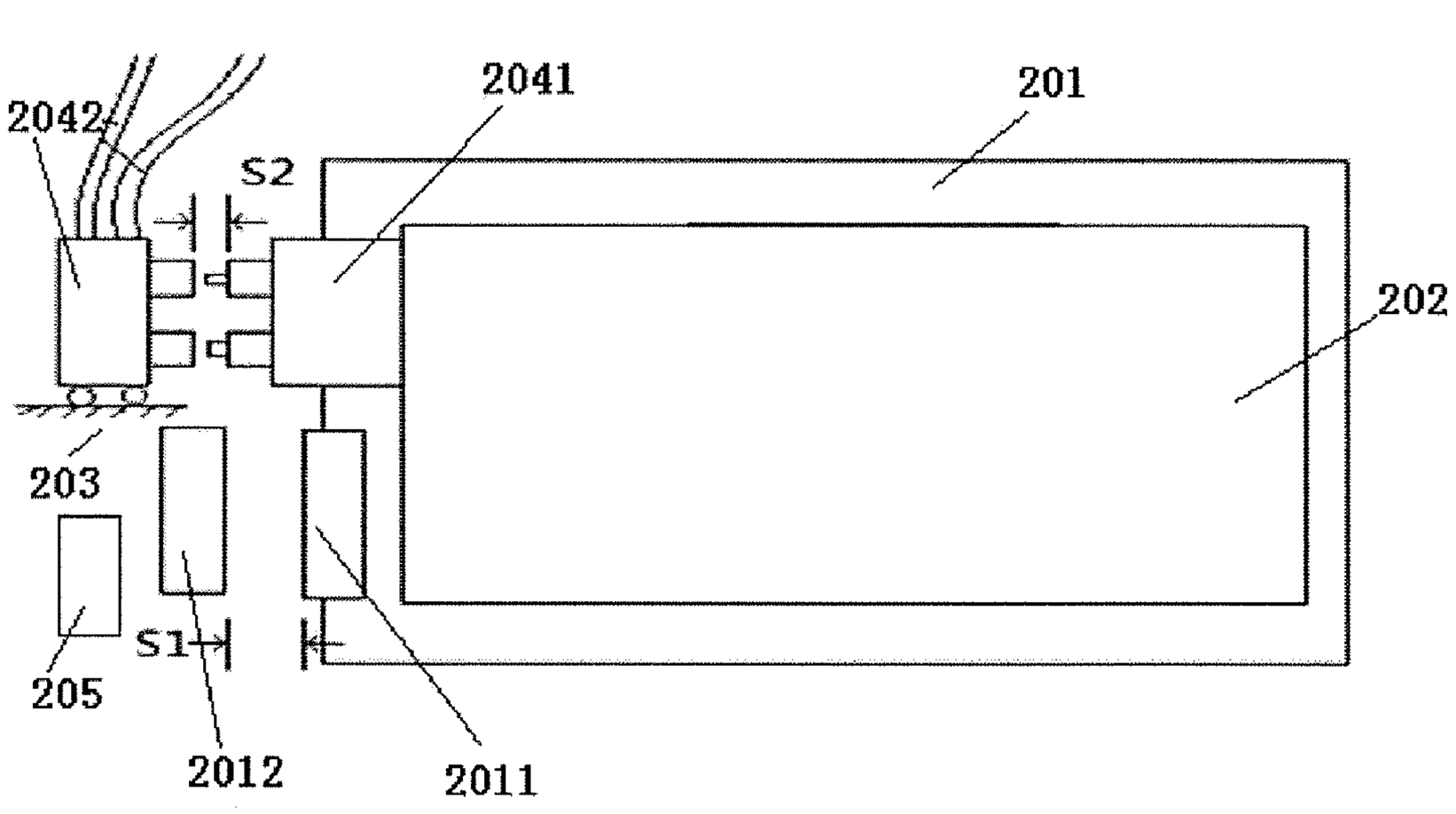
(57) **ABSTRACT**

Embodiments of the present invention disclose a liquid cooling apparatus, which includes a cold plate (**202**), a fast connector (**204**), and a first interface (**2011**), where the fast connector (**204**) includes a first connector (**2041**) and a second connector (**2042**), where the first connector (**2041**) is fixedly connected to the cold plate (**202**); the first interface (**2011**) is configured to connect to a second interface (**2012**) corresponding to the first interface; and the liquid cooling apparatus further includes a guide rail (**203**), where the guide rail (**203**) is a moving rail of the second connector (**2042**), and when the first connector (**2041**) and the second connector (**2042**) are in a connected state and the second connector (**2042**) is located at an end on the guide rail (**203**) that is close to a board (**201**), a distance between the first interface (**2011**) and the second interface (**2012**) is greater than 0.

4 Claims, 2 Drawing Sheets



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USPC ..... 62/259.2; 439/190–206, 377, 541.5, 439/607.35, 620.06, 620.12, 620.15, 439/620.22, 629, 876; 174/11 R; 361/724–728, 748, 760; 165/80.1, 80.4, 165/104.19, 104.31, 104.33, 185; 285/9.1
See application file for complete search history.

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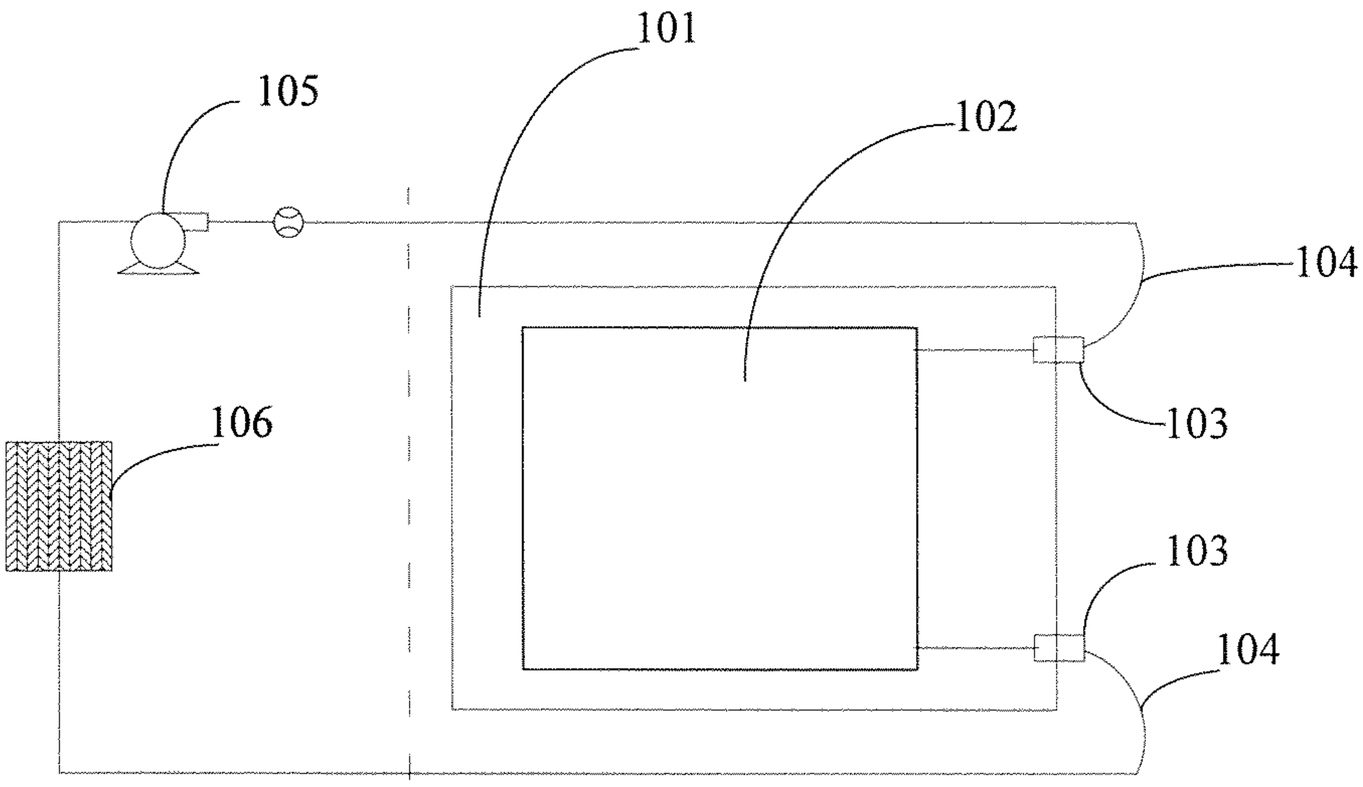

FIG. 1
(PRIOR ART)

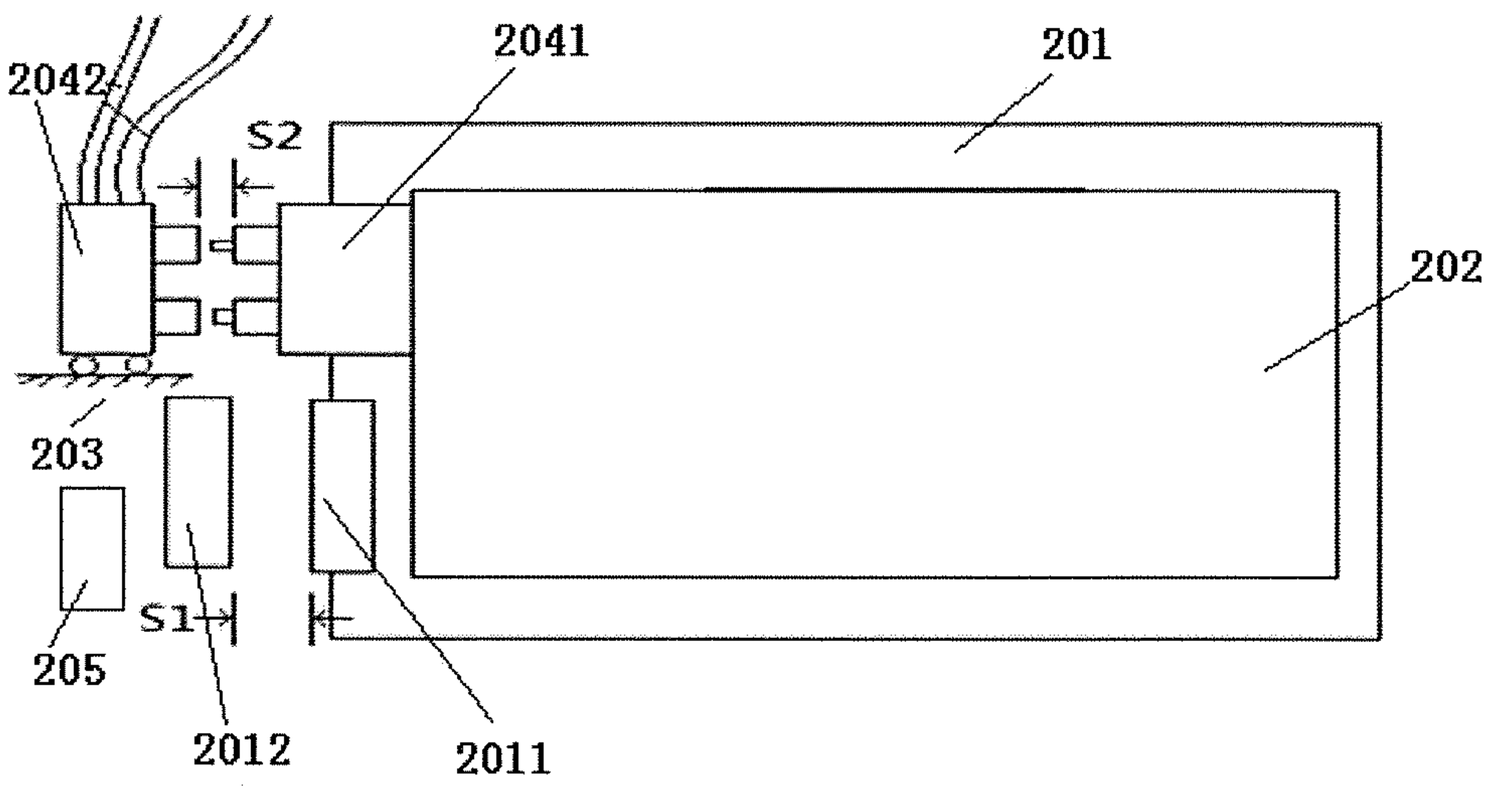

FIG. 2

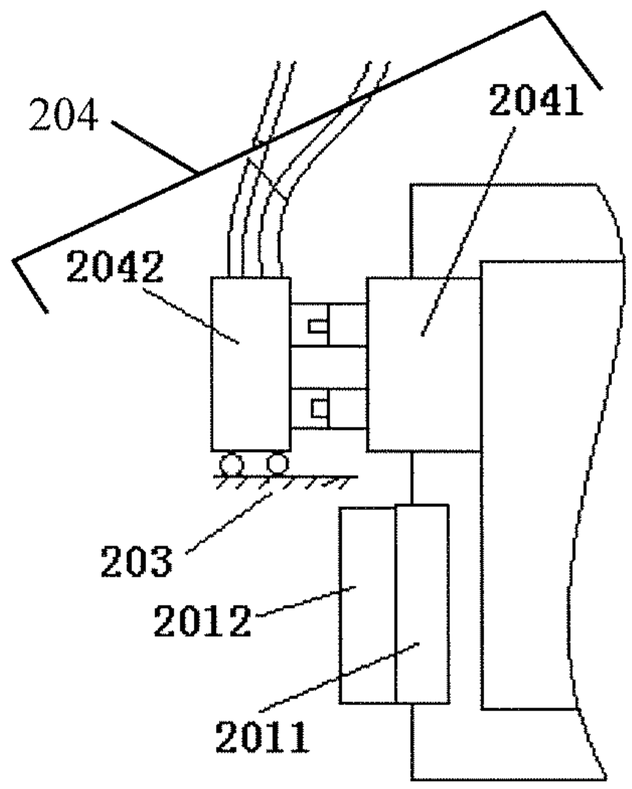

FIG. 3

LIQUID COOLING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of International Application No. PCT/CN2012/086285, filed on Dec. 10, 2012, which claims priority to Chinese Patent Application No. 201210118942.0, filed on Apr. 20, 2012, both of which are hereby incorporated by reference in their entireties.

TECHNICAL FIELD

The present invention relates to the field of communications technologies, and in particular, to a liquid cooling apparatus.

BACKGROUND

With development of communications service traffic, power consumption of a board becomes higher and higher. As a technology with a superb heat dissipation effect, liquid cooling heat dissipation will become a preferred solution to address high heat production. Because of a need of flexible product service configuration, maintenance, and upgrade, a board needs to have a hot swap function.

As shown in FIG. **1**, which is a schematic structural diagram of a system loop of a liquid cooling apparatus, the system loop includes: aboard **101**, a cold plate **102**, a fast connector **103**, a hose **104**, a pump **105**, and a heat sink **106**. The board **101** is a heat source. The cold plate **102** generally has metal plates and pipes, and liquid can flow inside the cold plate **102**. The cold plate **102** is closely attached to the board **101** to absorb heat of the board **101**. The cold plate **102** is connected to the fast connector **103** and the pump **105** through the hose **104**. The pump **105** is connected to the heat sink **106** through the hose **104**. The pump **105**, the heat sink **106**, the fast connector **103**, and the cold plate **102** are connected in serial mode through the hose to form an enclosed loop. The pump **105** provides a driving force for liquid to flow in the enclosed loop. Low-temperature liquid enters the cold plate **102**, absorbs heat of the board **101**, and becomes high-temperature liquid; the high-temperature liquid enters the heat sink **106** after flowing out of the cold plate **102**; the high-temperature liquid releases heat in the heat sink **106** and becomes low-temperature liquid; and the low-temperature liquid flows out of the heat sink **106** and enters the cold plate **102** again, thereby forming a circle. The board **101** has an interface and may be inserted in a slot. After being inserted in a slot and powered on, the board **101** enters a ready-to-work state.

Because of a need of flexible product service configuration, maintenance, and upgrade, the board generally has a hot swap function. A liquid cooling loop also needs to be connected or disconnected (inserting the hose **104** or removing the fast connector **103**) when the board is inserted or removed. According to current operation specifications and requirements, the liquid cooling loop is connected before the board is inserted, and the liquid cooling loop is disconnected after the board is removed. Currently, the insertion and removal of the board and the connection and disconnection of the liquid cooling loop are all manual operations, which are liable to a reverse sequence. Equipment may fail to work normally or even be severely damaged due to misoperation. Therefore, equipment reliability is low.

SUMMARY

Embodiments of the present invention provide a liquid cooling apparatus, which is used to reduce misoperation and improve equipment reliability.

A liquid cooling apparatus includes a cold plate, a fast connector, and a first interface, where:

the fast connector includes a first connector and a second connector, where the first connector is fixedly connected to the cold plate; the first interface is configured to connect to a second interface corresponding to the first interface; and the liquid cooling apparatus further includes a guide rail, where the guide rail is a moving rail of the second connector; and

when the first connector and the second connector are in a connected state and the second connector is located at an end on the guide rail that is close to the board, a distance between the first interface and the second interface is greater than 0.

It can be seen from the foregoing technical solution that, the embodiments of the present invention have the following advantage: Insertion or removal can be performed by only manually inserting a board along a slot on equipment, without requiring a person to operate and control an insertion or removal sequence, thereby reducing misoperation and improving equipment reliability.

BRIEF DESCRIPTION OF THE DRAWINGS

To describe the technical solution in the embodiments of the present invention more clearly, the following briefly introduces the accompanying drawings required for describing the embodiments. Apparently, the accompanying drawings in the following description show merely some embodiments of the present invention, and persons of ordinary skill in the art may still derive other drawings from these accompanying drawings without creative efforts.

FIG. **1** is a schematic structural diagram of a liquid cooling system loop in the prior art;

FIG. **2** is a schematic structural diagram after a liquid cooling apparatus according to an embodiment of the present invention is removed; and

FIG. **3** is a schematic structural diagram after a liquid cooling apparatus according to an embodiment of the present invention is inserted.

DETAILED DESCRIPTION

To make the objective, technical solution, and advantage of the present invention clearer, the following further describes the present invention in detail with reference to the accompanying drawings. Apparently, the described embodiments are merely a part rather than all of the embodiments of the present invention. All other embodiments obtained by a person of ordinary skill in the art based on the embodiments of the present invention without creative efforts shall fall within the protection scope of the present invention.

An embodiment of the present invention provides a liquid cooling apparatus, as shown in FIGS. **2** and **3**. Referring to FIG. **3**, the liquid cooling apparatus includes a cold plate **202**, a fast connector **204**, and a first interface **2011**.

The fast connector **204** includes a first connector **2041** and a second connector **2042**. The first connector **2041** is fixedly connected to the cold plate **202**. The first interface **2011** is configured to connect to a second interface **2012** corresponding to the first interface. The liquid cooling apparatus further includes a guide rail **203**.

The guide rail **203** is a moving rail of the second connector **2042**.

When the first connector **2041** and the second connector **2042** are in a connected state and the second connector **2042** is located at an end on the guide rail **203** that is close to the board **201**, a distance between the first interface **2011** and the second interface **2012** is greater than 0 (S1>S2, as shown in FIG. **2**).

Furthermore, the liquid cooling apparatus further includes a board **201**.

The cold plate **202** is attached to the board **201** for cooling the board **201**. The first interface **2011** is fixedly connected to the board **201**. It should be noted that, the board **201** is a board with a heat source component, and the liquid cooling apparatus dissipates heat for the board **201**, but the board **201** is not a mandatory part of the liquid cooling apparatus.

Furthermore, the liquid cooling apparatus further includes a liquid cooling control module and an electromagnet **205**.

The liquid cooling control module is configured to: when the first connector **2041** and the second connector **2042** are in a disconnected state, control the electromagnet **205** to attract the second connector **2042**, so that the second connector **2042** is fixed on the guide rail **203**; and when the first connector **2041** and the second connector **2042** are is a connected state, control the electromagnet **205** not to attract the second connector.

More specifically, the liquid cooling control module is configured to: when the first connector **2041** and the second connector **2042** are in a disconnected state, control the electromagnet **205** to enter a working state (that is, a power-on state, in which the electromagnet **205** will generate attraction to the second connector **2042**), where the electromagnet **205** in a working state attracts the second connector **2042** to fix the second connector **2042** on the guide rail **203**; and when the first connector **2041** and the second connector **2042** are in a connected state, control the electromagnet **205** to enter an idle state.

The liquid cooling control module and the electromagnet **205** implement an automatic switching between a fixed connection and an adjustable connection of the second connector **2042**, which can further reduce manual operations. An implementation manner for the liquid cooling control module to monitor whether the first connector **2041** and the second connector **2042** are in a connected state may be to monitor whether a liquid cooling loop constitutes a loop, or the monitoring may be implemented in another manner, which is not limited in the embodiment of the present invention.

Furthermore, the liquid cooling apparatus further includes a liquid cooling indicator. The liquid cooling control module is further configured to: when the first connector **2041** and the second connector **2042** are in a connected state, control the liquid cooling indicator to become on; and when the first connector **2041** and the second connector **2042** are in a disconnected state, control the liquid cooling indicator to become off.

Using a circuit indicator and a circuit control module can implement a function of indicating a connection and disconnection of the liquid cooling loop, making it convenient for an operator to view an operation state and an operation result.

Furthermore, the liquid cooling apparatus further includes:

the circuit indicator and the circuit control module, where the circuit control module is configured to: when the first interface **2011** and the second interface **2012** are in a connected state, control the circuit indicator to become on; and when the first interface **2011** and the second interface **2012** are in a disconnected state, control the circuit indicator to become off.

Using the circuit indicator and the circuit control module can implement a function of indicating a connection and disconnection of a circuit, making it convenient for an operator to view an operation state and an operation result. An implementation manner to monitor whether the first interface **2011** and the second interface **2012** are in a connected state may be to monitor whether a board is powered on, or the monitoring may be implemented in another manner, which is not limited in the embodiment of the present invention.

Preferably, the fast connector is a fast connector with a self-guide and/or self-lock function.

The following describes an operating principle of the liquid cooling apparatus provided by the embodiment of the present invention in detail:

1. Board insertion process:

Initial state: As shown in FIG. **2**, a first connector **2041** and a second connector **2042** are in a separate state. Therefore, an electromagnet **205** is in a working state, and the second connector **2042** is fixed on a guide rail **203**, as S1>S2 shown in FIG. **2**.

A liquid cooling loop connected: After the first connector **2041** and the second connector **2042** are connected, the first connector **2041** and the second connector **2042** are in a connected state, the electromagnet **205** stops working, and the second connector **2042** is in a movable state. At this time, a liquid cooling indicator becomes on. Because S1>S2, a first interface **2011** and a second interface **2012** are still not in contact at this time.

A board **201** inserted: As shown in FIG. **3**, the board **201** and a cold plate **202** are pushed, and the second connector **2042** slides on the guide rail **203** to a left side of the guide rail **203**; and the first interface **2011** and the second interface **2012** are connected to power on the board. At this time, a circuit indicator becomes on.

2. Board removal process:

The removal process is a reverse process of the board insertion process and is specifically as follows:

The board **201** removed: The board **201** moves to the right, the first interface **2011** and the second interface **2012** are separate, and the circuit indicator becomes off; the second connector **2042** slides on the guide rail **203** to a right side of the guide rail **203**; and because S1>S2, the first connector **2041** and the second connector **2042** are still in a connected state at this time.

The liquid cooling loop disconnected: The board **201** continuously moves to the right, the first connector **2041** and the second connector **2042** are separate, and the liquid cooling indicator becomes off; and because the first connector **2041** and the second connector **2042** are separate, the electromagnet **205** starts working and attracts the second connector **2042** to fix the second connector **2042** on the guide rail. Finally, a state shown in FIG. **2** is formed.

In the process, insertion or removal can be performed by only manually inserting the board along a slot on equipment, without requiring a person to control an insertion or removal sequence, thereby reducing misoperation and improving equipment reliability. A guide pin may further be disposed in a direction of inserting the board to facilitate alignment between the first connector **2041** and the second connector **2042**, and between the first interface **2011** and the second interface **2012**.

It should be noted that, the circuit control module and the liquid cooling control module are merely divided based on

functional logic, but are not limited to the preceding division, and any other division is acceptable as long as corresponding functions can be implemented. In addition, specific names of functional units are merely for mutual distinction, but are not intended to limit the protection scope of the present invention.

In addition, a person of ordinary skill in the art may understand that all or a part of the steps of the method embodiments may be implemented by a program instructing relevant hardware. The program may be stored in a computer readable storage medium. The storage medium may include: a read-only memory, a magnetic disk, or an optical disc.

The foregoing descriptions are merely specific exemplary embodiments of the present invention, but are not intended to limit the protection scope of the present invention. Any variation or replacement readily figured out by a person skilled in the art within the technical scope disclosed in the present invention shall fall within the protection scope of the present invention. Therefore, the protection scope of the present invention shall be subject to the protection scope of the claims.

What is claimed is:

1. A liquid cooling apparatus, comprising:

a board;

a cold plate attached to the board, the cold plate configured to cool the board;

a fast connector comprising a first connector and a second connector, wherein the first connector is fixedly connected to the cold plate;

a first interface fixedly connected to the board, the first interface configured to connect to a second interface;

a guide rail in contact with the second connector, the guide rail having a first end and a second end, the first end being closer to the board than the second end, wherein the second connector is configured to move along the guide rail;

an electromagnet; and

a liquid cooling control module configured to:

when the first connector and the second connector are in a disconnected state, control the electromagnet to attract the second connector, so that the second connector is fixed on the guide rail, and

when the first connector and the second connector are in a connected state, control the electromagnet to not attract the second connector,

wherein when the first connector and the second connector are in the connected state and the second connector is located at the first end of the guide rail that is closer to the board, the first interface and the second interface are separated such that the first interface does not contact the second interface.

2. The liquid cooling apparatus according to claim **1**, further comprising:

a liquid cooling indicator; and

the liquid cooling control module is further configured to:

when the first connector and the second connector are in the connected state, control the liquid cooling indicator to turn on, and

when the first connector and the second connector are in the disconnected state, control the liquid cooling indicator to turn off.

3. The liquid cooling apparatus according to claim **1**, further comprising:

a circuit indicator; and

a circuit control module configured to:

when the first interface and the second interface are in the connected state, control the circuit indicator to turn on, and

when the first interface and the second interface are in the disconnected state, control the circuit indicator to turn off.

4. The liquid cooling apparatus according to claim **1**, wherein the fast connector comprises at least one of a self-guide and a self-lock function.

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